# PART 10B

# PARTICULAR TECHNICAL SPECIFICATIONS FOR CIVIL, STRUCTURAL REQUIREMENTS

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**PART-10B**

**PARTICULAR TECHNICAL SPECIFICATIONS FOR CIVIL, STRUCTURAL REQUIREMENTS**

## A. Standard Basic Specifications

The “Standard Basic Specifications” Part-10A shall be followed for construction of General Works under this contract of BWSSB. Specifications for additional specialized items of civil works are as set out in Part 10B, Particular Technical Specifications, of this Section.

In the event of any discrepancy between the provisions of the Standard Basic Specifications and the Particular Technical Specifications, the provisions of the Particular Technical Specifications shall prevail.

## B. Particular Technical Specifications for STP, TSPS, ISPS & Connected Works

### 1.0 Design Submissions

Before proceeding with design and drawing preparation, the Contractor shall submit detailed general philosophy of design (Design Basis Report) of various parts of (all) the structures and equipment foundations along with explanatory sketches for review. Only after the review and incorporation of comments on the general philosophy, as offered during the review, the Contractor shall submit any design document and/or drawing for review and approval for construction.

### 1.1 Design Philosophy

Following are the details which are to be included in the general design philosophy document submission:

1. Design assumptions/philosophy for Liquid Retaining Structures with various boundary conditions as applicable

2. Design assumptions/philosophy for buildings

3. Design assumptions/philosophy for all other structures

4. Standard General Notes shall include material properties (grade, strength, unit weight etc.), development lengths, lap/splice lengths, Anchorage lengths under tension and compression, clear cover, water proofing specifications, legend used etc.

## 1.2 Standard Details

Following typical details shall also be submitted for approval prior to proceeding with detailed design:

1. Reinforcement detail showing the development length at Column/Footing intersection, Column and Roof beam intersections, Walls and Base slab intersections, Walls and cover slab intersections.

2. Detailing of the reinforcement for columns, beams, beam/column intersection, footing/column intersection, and Slabs as per relevant code provisions/requirements depending upon the assumptions made in the design as applicable.

3. Reinforcement detail for cut-outs in slabs and walls with maximum size of cut-outs

4. Reinforcement detail at top of RCC trench walls showing edge/seating angles

5. Pouring sequence of concrete and standard details for construction joints, expansion joints, contraction joints, etc.

6. Details of Opening/Manholes and Rungs to be placed in the tanks

7. Detail for rain water drainage down takes at terrace slab and water proofing at roof/sunken slabs

8. Detail for storm water drain, Roads, plinth protection and entrance ramps to buildings

9. Detail for Handrails and fixing detail of handrail to concrete, Steel Ladders and fixing detail of ladders to Walls/Concrete, Cage ladders, Boundary walls, Fencing and Gates, etc.,

## 1.3 Submission

***Contractor shall submit the detailed design and drawings only after items mentioned under clause 1.1 and 1.2 are approved or as directed by the Engineer***

Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be

submitted to the Engineer. Separate design calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and shall not be accepted by the Engineer.

Submissions of detailed design calculations and Good for Construction drawings shall include the following as a minimum:

A. Detailed Design Calculations
    1. One (1) Copy of a Compact Disc (CD) containing electronic files relevant to the structure's modelling, analysis and design calculations (Microsoft Excel, STAADPro, etc.). Files submitted shall be in editable format.

    2. Print copy (7Copies) of the contents as submitted in the Compact Disc.

B. Good for Construction Drawings
    1. One (1) Copy of a Compact Disc (CD) containing AutoCAD files (Civil General Arrangement, Structural Dimensions and Reinforcement Details) pertaining to the structure. Files submitted shall be in editable format.

    2. Print copy (7Copies) of the contents as submitted in the Compact Disc. Prints to be submitted on A1 Size Sheet as a minimum or A0 Size Sheet when required by the employer.

    3. Bar-bending schedule indicating the number, shape and size of the rebars shall be submitted as part of the Reinforcement Details.

    4. Detailed drawing showing the location, number and depth of inserts shall be included for any structural steel inserts/Metal inserts in the structure such as rungs, bolted connections for ladders/railings, etc.

    5. Location of Construction Joints and pour sequence shall be included on the drawing for base slabs, walls and top slabs.

    6. Revised drawings shall be submitted by clouding at the location with the latest revision number and also show the history of revisions in a table format just above the title block.

The design considerations described here under establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of partly completed structures.

## 1.4 Design Standards

All the designs shall be based on the latest Bureau of Indian Standard (BIS) Specifications or Codes of Practice. The design standards adopted shall follow the best modern engineering practice in the field based on any other International Standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by the Engineer. In case of any variation or contradiction between the provisions of the BIS Standards or Codes and the specifications given along with the tender document, the provision given in this Specification shall be followed.

All reinforced concrete structural design shall generally conform to the following publications of the Indian Standards Institution:

IS:456 : Code of Practice for plain and reinforced concrete
IS:875 : Code of Practice for design loads for buildings and structures (Part I to V)
IS:3370 : Code of Practice for concrete structures for the storage of liquids (Part I to IV)
IS:1893 : Criteria for earthquake resistant design of structures (Part 1to 4)
IS: 2974 : Code of Practice for design and construction of machine foundations(Part 1 to 4)
IS: 2911 : Code of practice for Design and construction of Pile foundations. (Parts 1 to 4)
IS:13920 : Ductile Detailing of Reinforced Concrete Structures subjected to Seismic forces- Code of Practice.
IS: 4326 : Code of Practice for Earthquake Resistant Design and Construction of Buildings
IRC: 6 : Standard specification and Code of Practice for road bridges Loads and Stresses
SP: 16 : Design Aids for Reinforced Concrete to IS 456
SP: 34 : Handbook on Concrete Reinforcement and Detailing.
SP: 23 : Handbook on Concrete Mixes.

All structural steel design shall generally conform to the following publications of the Indian Standards Institution:

I.S: 800 : Code of Practice for general construction in steel
I.S: 806 : Code of Practice for use of steel tubes in general building construction
SP: 38 : Handbook of Typified Design of Structures with Steel Roof Trusses

## 1.5 Design Life

The design life of all structures and buildings shall be 60 years.

## 1.6 Design Loadings

All buildings and structures shall be designed to resist the worst combination of the following loads/stresses under test and working conditions; these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads.

## 1.7 Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment's and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included, but excluding contents, shall be considered.
Dead loads shall be in general as per I.S. 875 Part (I). However, the following **minimum loads** shall be considered in design of structures:

| | | |
|---|---|---|
| (i) | Weight of water | 9.81 kN/$m^3$ |
| (ii) | Weight of soil (irrespective of strata available at site and type of soil used for filling etc). However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered | 20.00 kN/$m^3$ |
| (iii) | Weight of concrete | 24.00 kN/$m^3$ |
| (iv) | Weight of reinforced concrete | 25.00 kN/$m^3$ |
| (v) | Weight of brickwork (exclusive of plaster) | 22.00 N/$m^2$ per mm thickness of brickwork |
| (vi) | Weight of Solid Concrete Block work (exclusive of plaster) | 24.00 N/$m^2$ per mm thickness of block work |
| (vii) | Weight of plaster to masonry surface | 18.00 N/$m^2$ per mm thickness |
| (viii) | Weight of granolithic terrazzo finish or rendering screed, etc. | 24.00 N/$m^2$ per mm thickness |
| (ix) | Weight of sand (filter media) | 26.0 kN/$m^3$ |
| (x) | Weight of alum blocks | 24.20 kN/$m^3$ |
| (xi) | Weight of MS chequered plates | 78.5 N/$m^2$ per mm thickness of plates |

## 1.8 Live Load

Live Load (LL) shall include the superimposed loads due to the use/occupancy of the structure/building not including dead, wind or earthquake load. Live loads shall be in general as per I.S. 875 Part (II). However, the following **minimum live loads** shall be considered in the design of structures:

(i) Live load on roofs (accessible by staircase) : 1.50 kN/$m^2$

(ii) Live load on floors supporting equipment such as pumps, blowers,

| | | | |
|---|---|---|---|
| | compressors, valves etc. | : | 10.00 kN/$m^2$ |
| (iii) | Live load on all other floors walkways, stairways and platforms | : | 5.00 kN/$m^2$ |
| (iv) | Live load on Toilet areas | : | 2.00 kN/$m^2$ |

(v) Surcharge for underground structures
Including channels, sumps, cable & pipe trenches etc. : 20.00 kN/$m^2$

In the absence of any suitable provisions for live loads in BIS Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of the Engineer prior to starting the design work. Apart from the specified live loads or any other load due to material

stored, any other equipment load or possible overloading during maintenance or erection/construction shall be considered and shall be partial or full whichever causes the most critical condition.

### 1.9 Wind Load

Wind loads shall be as per I.S. 875 Part (III).

### 1.10 Earthquake Load

This shall be computed as per I.S. 1893. An importance factor appropriate to the type of structure shall be considered for design of all the structures. For design of all Process buildings and structures an importance factor of 1.75 shall be adopted.

### 1.11 Dynamic Load

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, travelling cranes, etc. shall be considered in the design of foundation of such structures. As a guide, the mass of the foundation should be at least 2.5 times the mass of the whole machine or as provided by the manufacturer/Vendor for dynamic analysis.

### 1.12 Vehicular Wheel Load

For any structure or pipeline below the roads, Class A loading of IRC 6 shall be considered.

### 1.13 Joints

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure.

However, contraction joints shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for walls and rafts.

Expansion joints of suitable gap at suitable intervals not more than 30 m shall be provided in walls, floors and roof slabs of liquid retaining structures.

Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction.

To avoid segregation of concrete in walls, vertical construction joints are normally to be provided at corners and junction of walls and in Base slab. PVC water stops of 150mm width shall be used for walls and 230mm width for base slabs.

## 1.14 Design Criteria for Underground or Partly Underground Liquid Retaining Structures

Water level is assumed at the ground level for design of all the structures. All underground or partly underground liquid containing structures shall be designed for the following conditions:

(i) Liquid depth up to full height of wall: no relief due to soil pressure from outside to be considered.

(ii) Structure empty (i.e., empty of liquid, any material, etc.): full earth pressure and surcharge pressure wherever applicable, to be considered.

(iii) If water table exists, earth pressure to be considered for submerged soil conditions with reference to geotechnical recommendations, approved by the Engineer.

(iv) Partition wall between dry sump and wet sump: to be designed for full liquid depth up to full height of wall.

(v) Partition wall between two compartments: to be designed as one compartment empty and other full.

(vi) Structures shall be designed for uplift in empty conditions with the water table considered at FGL.

(vii) Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads (Hydrodynamic Impulsive Pressure).

(viii) For general retaining walls and large sized tanks where the walls are designed as retaining walls, sliding check shall also be performed along with over turning checks.

**Overturning:** The stability of a structure as a whole against overturning shall be ensured so that the restoring moment shall be not less than the sum of 1.2 times the maximum overturning moment due to the characteristic dead load and 1.4 times the maximum overturning moment due to the characteristic imposed loads. In cases where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Restoring moment due to imposed loads shall be ignored.

(ix) **Sliding:** The structure shall have a factor against sliding of not less than 1.4 under the most adverse combination of the applied characteristic forces. In this case only 0.9 times the characteristic dead load shall be taken into account as per IS codes.

(x) Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. The stability of the structure should be checked against uplift using Factor of safety of 1.2. The individual members shall be designed for stresses due to uplift forces.

(xi) All the liquid retaining structures shall be design for maximum design crack widths of 0.1mm for direct tension and flexure.

(xii) In case of Large and Deep Underground Tanks, the analysis can be carried by Finite Element Method using STAAD.Pro or any other equivalent software predominantly used and accepted in the industry.

## 1.15 Foundations

(i) The minimum depth of foundations for all structures, equipments, buildings and frame foundations and load bearing walls shall be as per IS 1904 but in any case this shall not be less than 1.0 meter in the original soil.

(ii) Maximum safe bearing capacity of soil strata shall be taken as determined by the Bidder through his own independent investigations. Geotechnical reports of proposed sites covered under the contract are available with the employer for reference. It may be used by Contractor as part of, in addition to, or in lieu of such investigations at his own risk.

(iii) The Bidder shall ensure the technical feasibility of the offer submitted after visiting the sites and conducting independent investigations. It must be clearly understood by the bidder that as the contract is Design , Build and Operate, the contractor shall be required to design and execute every such item(s) of work(s) which are considered required or necessary for the satisfactory completion and functioning of the entire work, commissioning of electro-mechanical equipment , Instrumentation, SCADA systems, trial run and operation and maintenance , and any other

items required but not specified in the bid document, but are essential to complete the scheme. Nothing extra or additional shall be paid to the contactor on account of his failure of understanding.

(iv) Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.

(v) Special attention is drawn to danger of uplift being caused by the ground water table. All underground structural slabs shall be designed for uplift forces due to ground water pressure.

(vi) EGL (Existing ground level) and FGL (Finished ground level) shall be marked on all drawings showing foundation/sub-structure details and related design documents.

(vii) Machine/static equipment foundations shall be separated from adjoining parts of buildings, other foundations and floor/pavement slabs. Joints at floor/pavement slabs shall be suitably sealed.

(viii) Foundations and structures for machines subject to vibrations shall be so proportioned that the amplitude and frequency of the foundation/structure are within the permissible limits as per relevant BIS codes (or as required by the machine vendor).

(ix) Machine foundations shall be designed and detailed as per IS: 2974. All appendages to such foundations shall be reinforced suitably to ensure integral action.

(x) Pile Foundations - Design, Testing and Execution of piles shall be considered as per provision of relevant codes (conforming to latest version of IS: 2911), and in compliance with the Geotechnical report recommendations as applicable.

## 1.16 Design Requirements

The following are the design requirements for all reinforced or plain concrete structures:

a) All blinding and leveling concrete shall be a minimum 100 mm thick in concrete grade M10.

b) All liquid retaining reinforced concrete structures, concrete shall be of a minimum M30 grade and Buildings, shall be of a minimum M25 grade (Footings, Plinth Beams, Columns, Slab and beams, etc., i.e. which are other than liquid retaining structures). Further, if there are any liquid retaining RCC tanks coming up with in the buildings, concrete shall be of minimum M30 grade for such RCC tanks also.

c) The reinforced concrete for liquid retaining structures shall have a minimum cement content of 400 kg/m$^3$ for M30 grade concrete and building structures shall have minimum cement content of 360 kg/m$^3$ with M25 grade concrete. Reinforced concrete shall have maximum slump of 100 mm and maximum water cement ratio of 0.48.

d) The minimum clear cover to all reinforcement including stirrups and links shall be 60 mm for all liquid retaining structures except for Launders/Gutter Slabs cover shall be 45mm. As design consideration to control crack, though general requirements of IS 3370 shall be followed, permissible crack width shall be limited to 0.1 mm for liquid retaining structures.

e) The minimum amount of reinforcement in each of the two directions at right angles within each surface zone should be provided as per clause 8.1 of IS 3370 (Part 2):2009. Definition of surface zones is clearly shown in Figure 1 and Figure 2 of IS 3370 (Part 2): 2009. For slabs, minimum of 10 mm dia bars shall be used to avoid any deformation of lesser diameter bars under loads prior to construction. Any liquid retaining structures which are more than 165mm thickness shall have reinforcement on both the faces..

f) The minimum cover to the main reinforcing bars for different members

**1. Non–liquid retaining structures** shall be as follows unless stated otherwise:

| | |
|---|---|
| Slab (Floor, Roof, Canopy, and Staircase) | 30 mm |
| Shell roof for Filter house/Clarifiers | 25 mm |
| Beams (Sides, Bottom & Top) | 40 mm |
| Lintels (all around) | 30 mm |
| Columns | 50 mm |
| Pedestals (in contact with earth) | 50 mm |
| Basement wall, Retaining walls | |
| i) Face in contact with earth | 50 mm |
| ii) Interior face | 40 mm |
| Foundations | 50 mm |

**2. Liquid retaining structures** shall be as follows unless stated otherwise:

| | |
|---|---|
| Walls – Face in contact with earth | 60 mm |
| Walls – Face in contact with water | 60 mm |
| Base slab in contact with water | 60 mm |
| Base slab in contact with soil | 60 mm |
| Launders/Gutter slabs | 45 mm |
| Roof slab | 45 mm |
| Manhole | 50 mm |

g) For reinforced concrete structures, reinforcement shall be HYSD-CRS (Corrosion Resistant Steel) of Grade Fe 500. All physical and chemical properties of this Fe 500 grade steel shall confirm to IS: 1786-2008. Welded wire fabric shall conform to IS: 1566 as shown or specified on the drawing. The CRS (corrosion resistant steel) index shall be at least 1.35 when tested for Salt Spray test as per "ASTM B 117 – 2009 test procedure for 120 hours when compared with the Fe 500 normal reinforcement bars and with same bar diameter. All test results (including physical and chemical properties and salt spray tests) have to be produced for the respective bar diameter for each consignment of steel delivered at site and at a frequency of every 20 Metric Tons.

h) Reinforcement bars and structural steel to be procured only from Primary steel producers/Integrated Steel Plants such as SAIL/RINL/JSW/SHYAM STEEL using iron ore as the basic raw material and having in-house iron making facilities followed by production of liquid steel and crude steel with in-house rolling, adopting BF-BOF route or DRI-EAF technology as per Ministry of Steel guidelines. No Re-rolled material/secondary steel shall be accepted or allowed for any structural works. The steel manufacturing company should have latest ISO accreditation for Quality Management System.

i) All buildings shall have a minimum 1 meter wide, minimum 100 mm thick plinth protection paving in M15 grade concrete. Plinth protection shall be supported on well compacted strata of soling about 150mm/ plain cement concrete as required.

j) All pipes and ducts laid below the structural plinth and road works shall be surrounded with concrete of grade M15 having minimum 150 mm thick concrete or D/4 (D = outer dia. of pipe) thickness whichever is more.

k) Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.

l) Detailing of the reinforcement shall be considered as per latest Indian code of practices and special publications as applicable.

m) Any structure or pipeline crossing below roads shall be designed for Class A of IRC loading.

n) Sliding layer or slip layer shall be provided between sub base and structural slab (Raft). Polythene sheets of 500 microns shall be provided as sliding layer as per IS specification.

o) Water tightness testing of liquid retaining structures shall be done in accordance with IS: 3370, (Part I) - 2009. It is described in Clause 1.31 of this document. The depth of water for testing shall be as per design depth.

p) A layer of 300mm thick rubble packing with approved stone, set in regular lines, hand-packed, filling the interstices with approved small stone chips and sand, consolidating by ramming or compacting with heavy roller after watering including spreading of 12mm layer of stone grit on top shall be carried out for all building works below grade slabs/rafts/footings under water logged conditions/high water table conditions.

The following minimum thicknesses shall be used for different reinforced concrete members, irrespective of design thicknesses:

| | | | |
|---|---|---|---|
| (i) | Walls for liquid retaining structures | : | 250 mm |
| (ii) | Roof slabs for liquid retaining structures (Other than flat slabs) | : | 200 mm |
| (iii) | Bottom slabs/Raft for liquid retaining structures | : | 300 mm |
| (iv) | Floor slabs including roof slabs, walkways, canopy slabs | : | 125 mm |
| (v) | Walls of cables / pipe trenches, underground pits etc. | : | 200 mm |
| (vi) | Column footings | : | 300 mm |
| (vii) | Parapets | : | 100 mm |
| (viii) | Precast trench cover, Chajja and all fascias | : | 100 mm |
| (ix) | Column Dimension | | |
| | a) Exceptional case (Based on any specific requirement) | | |
| | i) To match with width of block masonry wall | : | 200mm |
| | ii) To match with width of brick masonry wall | : | 230mm |
| | b) In general case | : | 300mm |
| (x) | Beam (To match with width of block masonry wall) | : | 200mm |
| (xi) | Launder Base Slab/Baffle walls | : | 200 mm |
| (xii) | Launder Vertical Wall, Baffle Wall, Gutter Slab | : | 175 mm |
| (xiii) | Grade Slabs | : | 200 mm |

## 1.17 Materials in General

The term "materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.

Except as may be otherwise specified for particular parts of the works the provision of clauses in "Materials and Workmanship" shall apply to materials and workmanship for any part of the works.

All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.

As soon as practicable after receiving the order to commence the Works, the Contractor shall inform to the Engineer of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of the Engineer which may be withheld until samples have

been submitted and satisfactorily tested. The Contractor shall thereafter keep the Engineer informed of orders for and delivery dates of all materials.

Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination failing which such damaged materials shall be rejected and shall not be used on any part of the Works under this contract.

## 1.18 Samples and Tests of Materials

The Contractor shall submit samples of such materials as may be required by the Engineer and shall carry out the specified tests directed by the Engineer at the Site, at the supplier's premises or at a laboratory approved by the Engineer.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer.

The Contractor shall give the Engineer seven days' notice in writing of the date on which any of the materials shall be ready for testing or inspection at the supplier's premises or at a laboratory approved by the Engineer. The Engineer shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by the Engineer to carry out such a test on a mutually agreed date in his presence. The Contractor shall in any case submit to Engineer within seven days of every test such number of certified copies (not exceeding six) of the test results as the Engineer may require.

Approval by the Engineer as to the placing of orders for materials or as to samples or tests shall not prejudice any of the Engineer's powers under the Contract.

The provisions of this clause shall also apply to materials supplied under any nominated sub-contract.

## 1.19 Standards

Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current on the date of submission of the tender.

Where the relevant standard provides for the furnishing of a certificate to the Engineer, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to the Engineer.

The specifications, standards and codes listed below are considered to be part of this specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between the Specification and the Standards referred to herein, the Specification shall govern.

**a) Materials**

IS: 269 - Specification for ordinary Portland cement.

IS: 383 - Specification for coarse and fine aggregates from natural sources for concrete

IS: 428 - Specification for distemper, oil emulsion, colour as required

IS: 432 - Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement (Parts 1 & 2)

IS: 455 - Specification for Portland slag cement

IS: 458 - Specification for precast concrete pipes (with and without reinforcement)

IS: 650 - Specification for standard sand for testing of cement

IS: 651 - Specification for salt glazed stoneware pipes and fittings

IS: 777 - Specification for glazed earthenware tiles

IS: 808 - Specification for dimensions for hot rolled steel beam, column channel and angle sections

IS: 814 - Specification for covered electrodes for manual metal arc welding of Carbon and Carbon Manganese steel

IS: 1003 - Specification for timber paneled and glazed shutters (Parts 1 & 2)

IS: 1038 - Specification for steel doors, windows and ventilators

IS: 1077 - Specification for common burnt clay building bricks

IS: 1398 - Specification for packing paper, water proof, bitumen laminated

IS: 1489 - Specification for Portland pozzolana cement (Parts 1 & 2)

IS: 1566 - Specification for hard drawn steel wire fabric for concrete reinforcement

IS: 1580 - Specification for bituminous compounds for water proofing and caulking purposes

IS: 1786 - Specification for high strength deformed steel bars and wires for concrete reinforcement

IS: 1852 - Specification for rolling and cutting tolerances for hot rolled steel products

IS: 1948 - Specification for aluminium doors, windows and ventilators

IS: 1977 - Specification for structural steel (ordinary quality)

IS: 2062 - Specification for steel for general structural purposes

IS: 2140 - Specification for Stranded Galvanized Steel Wire for Fencing

IS: 2185 - Specification for concrete masonry units (Parts 1 & 2)

IS: 2202 - Specification for wooden flush door shutters (Parts 1 & 2)

IS: 2645 - Specification for integral cement water proofing compounds

IS: 2750 - Specification for steel scaffoldings

IS: 2835 - Specification for flat transparent sheet glass

IS: 3384 - Specification for bitumen primer for use in waterproofing and damp proofing

IS: 3502 - Specification for steel chequered plates

IS: 4021 - Specification for timber door, window and ventilator frames

IS: 4350 - Specification for concrete porous pipes for under drainage

IS: 4351 - Specification for steel door frames

IS: 4990 - Specification for plywood for concrete shuttering work

IS: 9862 - Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting

IS: 10262 - Recommended guidelines for concrete mix design

IS: 12330 - Specification for sulphate resisting Portland cement

IS: 12709 - Glass fiber reinforced plastics (GRP) pipes, joints and fittings for use for potable water supply

**b) Tests**

IS: 516 - Method of test for strength of concrete

IS: 1182 - Recommended practice for radiographic examination of fusion - welded butt joints in steel plates

IS: 1199 - Methods of sampling and analysis of concrete

IS: 2386 - Methods of test for aggregates for concrete (Parts 1 to 8)

IS: 2720 - Methods of test for soils (Parts 1 to 39)

IS: 2911 - Code of Practice for design and construction of Pile foundations (Part 4)

IS: 3025 - Methods for sampling and test (physical and chemical) for water and wastewater (Parts 1 to 59)

IS: 3495 - Method of test for burnt clay building bricks (Parts 1 to 4)

IS: 3613 - Acceptance tests for wire flux combination for submerged arc welding

IS: 4020 - Methods of tests for wooden flush doors shutters: Type tests

IS: 4031 - Methods of physical tests for hydraulic cement (Parts 1 to 15)

IS: 5807 - Method of test for clear finishes for wooden furniture (Parts 1 to 6)

IS: 7318 - Approval tests for welders when welding procedure approval is not required (Parts 1 and 2)

IS: 13311 - Methods of Non-destructive testing of Concrete: Part 1 & Part 2

**c) Codes of Practice**

IS: 456 - Code of practice for plain and reinforced concrete

IS: 783 - Code of practice for laying of concrete pipes

IS: 800 - Code of practice for general construction in steel

IS: 806 - Code of practice for use of steel tubes in general building construction

IS: 816 - Code of practice for use of metal arc welding for general construction in mild steel

IS: 817 - Code of practice for training and testing of metal arc welders

IS: 875 - Code of practice for design loads (other than earthquake) for building structures (Parts 1 to 5)

IS: 1081 - Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators

IS: 1172 - Code of practice for basic requirements for water supply, drainage and sanitation

IS: 1477 - Code of practice for painting of ferrous metals in buildings (Parts 1 & 2)

IS: 1597 - Code of practice for construction of stone masonry (Parts 1 & 2)

IS: 1742 - Code of practice for building drainage

IS: 1893 - Criteria for earthquake resistant design of structures (Part 1)

IS: 1904 - Code of Practice for Design and Construction of Foundation in Soils :General Requirements.

IS: 1948 - Specification of aluminium doors, windows and ventilators

IS: 2065 - Code of practice for water supply in buildings

IS: 2204 - Code of practice for construction of reinforced concrete shell roof

IS: 2210 - Code for design of reinforced concrete shell structures and folded plates

IS: 2212 - Code of practice for brickwork

IS: 2338 - Code of practice for finishing of wood and wood based materials (Parts 1 & 2)

IS: 2394 - Code of practice for application of lime plaster finish

IS: 2395 - Code of practice for painting, concrete, masonry and plaster surfaces
(Parts 1 & 2)

IS: 2470 - Code of practice for installation of septic tanks (Parts 1 & 2)

IS: 2502 - Code of practice for bending and fixing of bars for concrete reinforcement

IS: 2571 - Code of practice for laying in-situ cement concrete flooring

IS: 2595 - Code of practice for radiographic testing

IS: 2751 - Recommended practice for welding of mild steel plain and deformed bars for reinforced construction

IS: 2911 - Code of Practice for design and construction of Pile foundations

IS: 2974 - Code of practice for design and construction of machine foundations
(Parts 1 to 4)

IS: 3114 - Code of practice for laying of Cast Iron pipes

IS: 3370 - Code of practice for concrete structures for the storage of liquids
(Parts 1 to 4)

IS: 3414 - Code of practice for design and installation of joints in buildings

IS: 3558 - Code of practice for use of immersion vibrators for consolidating concrete

IS: 3658 - Code of practice for liquid penetrate flaw detection

IS: 3935 - Code of practice for composite construction
IS: 4000 - Code of practice for High strength bolts in steel structures
IS: 4014 - Code of practice for steel tubular scaffolding (Parts 1 & 2)
IS: 4111 - Code of practice for ancillary structures in sewerage system (Parts 1 to 4)
IS: 4127 - Code of practice for laying of glazed stoneware pipes
IS: 4326 - Code of practice for Earthquake Resistant Design and Construction of Buildings
IS: 4353 - Recommendations for submerged arc welding of mild steel and low alloy steels
IS: 5329 - Code of practice for sanitary pipe work above ground for buildings
IS: 5334 - Code of practice for magnetic particle flaw detection of welds
IS: 5822 - Code of practice for laying of welded steel pipes for water supply
IS: 7215 - Tolerances for fabrication of steel structures
IS: 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels
IS:10005 - SI units and recommendations for the use of their multiples and of certain other units
SP: 16 - Design Aids for Reinforced Concrete to IS 456
SP: 34 - Handbook on Concrete Reinforcement and Detailing
SP: 38 - Handbook of Typified Design of Structures with Steel Roof Trusses

**d) Construction Safety**

IS: 3696 - Safety code for scaffolds and ladder (Parts 1 & 2)
IS: 3764 - Safety code for Excavation work
IS: 7205 - Safety code for erection of structural steel work

## 1.20 General Arrangement of Plant

The following general guidelines shall be followed in the preparation of general arrangement of Plant:

- Sufficient room shall be allowed between components of plant and adjacent Plant or fixed structures to permit safe and convenient access for operation and maintenance.

- An area adjacent to all mechanical Plant shall be provided as maintenance lay down area.

- fixed runways , lifting eyes or other means shall be provided to permit the removal of Plant that may be required to be removed during the course of its normal operational life for maintenance or any other purpose.

- areas where leakage is likely to occur whether in normal use or during maintenance shall be provided with covered drainage channels which shall direct spillage either to a suitable plant drain or to a sump from where it can be pumped to plant drain.

## 1.21 Orientation

The works shall be laid out within the confines of the Site in order to interface to the existing infrastructure of roadways and inlet and outlet pipe work. Underground services requiring to be relocated in order to accommodate the proposed site layout shall, with the approval of the Engineer, be relocated by the Contractor.

## 1.22 Buildings and Structures

All the building and structure works shall generally comply with the following Employer's Requirements unless otherwise specified elsewhere.

1. All building works shall be of reinforced concrete framework (Concrete Grade of M25 as a minimum).

2. All external walls shall be in solid cement concrete blocks of concrete grade M15 and shall be provided as per IS: 2185 (Latest Revision) and shall be 200 mm thick.

3. All internal partition walls shall be in solid concrete blocks of concrete grade M15 and shall be provided as per IS: 2185 (Latest Revision). All internal walls shall be 200mm thick except for toilets. Toilet partition walls shall be in 100 mm thick solid concrete block.

4. (a) Finishes to concrete liquid retaining structures shall be :
   F1 - External surfaces, buried
   F2 - External surfaces exposed and up to 300 mm below ground level
   F2 - Internal surfaces
   (b) Finishes to other concrete structures shall be :
   F1 - Buried
   F1 - Exposed, where plastering is specified
   F2 - Exposed

The type of finishes is explained in "Standard Basic Specifications for Civil and Structural Works" in Chapter 4.

5. All internal masonry surfaces finish shall have 12 mm thick plain faced cement plaster in cement mortar (1:4) with neat cement finish on top. Over this, one coat of primer and two coats of plastic emulsion paint of approved quality and shade shall be provided.

6. All external masonry surfaces and concrete surfaces with rough board finish shall have 20 mm thick sand faced cement plaster in two coats, base coat 12 mm thick in cement mortar 1:4 and finishing coat 8 mm thick in cement mortar 1:4. Waterproofing compound of approved make and quality shall be added to the cement mortar in proportions as specified by the manufacturer.

7. All external surfaces above ground level shall have one coat of primer and two coats of waterproof cement-based paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon.

8. Toilet areas, walls and ceilings, shall have one coat of primer and two coats of plastic emulsion paint.

9. Toilet floor slab shall be filled with brick bat coba (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company.

10. The finished floor level in toilet areas shall be 25 mm below general finished floor level elsewhere in the building.

11. The flooring in operator's room, loading/unloading bay, MCC cum Panel room shall be in 25mm thick Kota stone slab of approved shade and pattern and placed over 20 mm thick base of cement mortar 1:4 to give overall thickness of 45 mm. Half tile skirting shall also be provided in these areas.

12. The flooring in the pumping stations, chlorination building, centrifuge building, workshop, blower room, chemical building, security room, D.G.Room, any other equipment room,etc.., shall be 60mm thick cement flooring with Metallic concrete hardener topping, under layer of 42mm thick cement concrete 1:2:4 (1 cement : 2 coarse : 4 graded stone aggregate 16mm thick nominal size) and top layer of 18mm thick metallic concrete hardener consisting of mix 1:2 (1 cement : 2 stone aggregate 6mm nominal size) by volume & mixed with metallic hardening compound of approved quality @ 3 kg/$m^2$. Including cement slurry and rounding off edges.

13. Toilet areas shall have 300 mm x 600 mm x 6 mm thick ceramic non slippery tiles placed in cement mortar 1:4 to give an overall thickness of 50 mm. 2100 mm high dado, in 150 mm x 150 mm x 6 mm thick glazed tiles (approved make, shade and pattern) placed in cement mortar 1:3 shall also be provided in these areas.

14. The flooring along with skirting in administration building including PLC and SCADA Room shall be 20 mm thick mirror polished, machine cut granite slab of approved shade and pattern placed in cement mortar (1:4). 150mm high skirting shall be provided in these areas. 750mm wide

Granite stone shall be provided for laboratory platforms fixed over double sandwiched support as directed and the edges of granite is to be embedded into the wall.

15. The laboratory shall consist of cupboards/ almirahs/ cabinets made from suitable marine grade waterproof plywood. The floor tiles and dado shall be done with ceramic unglazed vitreous Acid resistant tiles 300mm x 300mm size of approved quality.

16. The toilet facilities shall include at least:
    (i) 2 Nos. Water closets with white porcelain Orissa pan minimum 580 mm long with flushing cistern of 10 liters capacity.

    (ii) 2 Nos. Urinals of sizes 600 mm x 400 mm x 300 mm flat back type in white porcelain separated by a marble partition of size 680 mm x 300 mm.

    (iii) 2 Nos. wash basins of size 510 mm x 400 mm in white porcelain with inlet, outlet and overflow arrangements.

    (iv) 2 Nos. mirror of size 400 mm x 600 mm wall mounted type fitted over wash basins.

    (v) 2 Nos. plastic liquid soap bottles.

    (vi) 2 Nos. Stainless steel towel rails minimum 750 mm long.

    (vii) All stopcocks, valves and pilar cocks shall be heavy duty chromium plated brass.

    (viii) All fittings such as `P' or `S' traps, floor traps, pipes, down take pipes etc.

    (ix) The sewage from toilet blocks shall be led to the wet well of terminal sewage pumping station if present under this contract or to the closest gravity sewer or with soak pit with septic tank with necessary arrangements.

17. All staircases shall have granite non-skid tiles for treads and risers of approved make and shade and half tile skirting set in cement mortar in 1:4 to be provided. All concrete stairs shall have aluminium nosing over 2 mm thick rubber strip of width same as nosing for the full length of the tread. Nosing shall be fixed with countersunk screws.

18. Stairways shall be provided to permit access between different levels within buildings. Staircase shall be minimum 1200mm wide, minimum Tread = 250 mm, maximum Riser = 175 mm and maximum 15 number of steps per flight unless specified otherwise. Staircases in general shall not

be steeper than 40°. The maximum vertical run for a single flight of stairs shall be 3.0 M.

19. All roof tops and overhead tanks shall be made accessible with ladder provision. Vertical step ladders fitted with landing point extensions shall be permitted where considered appropriate by the Engineer to access areas not frequently visited. Steel staircases shall be constructed of standard channel stringers with M.S. grating treads 25mm thick with non-skid nosing. Steel Ladders shall be minimum 600mm wide and shall not exceed 6m of straight and shall be painted with epoxy paint. PVC encapsulated Cast Iron rungs or step shall be provided on the inner side walls of all the liquid retaining structures at 300mm spacing.

20. All hand railing shall be provided with 6063-T6 Aluminium Alloy with an ultimate tensile strength of at least 207 MPa and yield strength of at least 172 MPa. The minimum height of hand railing shall be 1m and maximum spacing of verticals shall be 1.5 m- (25mm NB) . Number of horizontal rails shall be 3 (1 top-32 mm, 1 intermediate- 25mm and 1 bottom- 25mm) with a 100 x 2.5 toe plate at the bottom.

21. The reinforced concrete roofs shall be made waterproof by application of an approved roof polythene / bitumen membrane brick bat coba/ Yelahanka tiles. The finished roof surface shall have adequate slope to drain quickly the rain water to R.W down take inlet points.

22. All roof floors shall have minimum 750 mm height solid concrete block parapet wall where accessible is provided and shall have minimum 300 mm height solid concrete block parapet wall where accessible is not provided.

23. For roofing drainage, uPVC 6kg/sqm rainwater down takes with Bell mouth and uPVC grating at top shall be provided. For roof areas up to 40 sqm minimum two nos. 110 mm diameter down take pipes shall be provided. For every additional area of 40 sqm or part thereof, at least one no. 110 mm dia. down take pipe shall be provided.

24. Top surfaces of chajjas and canopies shall be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rain water. All chajjas and canopies shall be provided with drip moulding.

25. Building plinth shall be minimum 500 mm above average finished ground level around building. Damp proof course shall be minimum 75mm thick in cc 1:3:6.

26. All doors, windows, rolling shutters shall have lintels above. Chajja protection to lintels on external walls shall be such as to prevent the rain water splashing into the building. Chajja projection of minimum 750 mm for rolling shutters, 600 mm for doors and 600 mm for windows shall be

provided to prevent the rain water splashing into the building. Chajja shall be projected 150 mm on either side from size of doors/windows/rolling shutters.

27. All windows and ventilators shall have 25 mm thick Bull nosed Granite stone sills bedded in cement mortar (1:3).

28. All doors, windows and ventilators shall be made of aluminium confirming to latest version of IS: 1948. All fixtures for doors, windows and ventilators shall also be of aluminium and shall be provided as per IS specifications. Aluminium grills shall be provided in all the windows. Doors shall be in two panel and both panels shall be glazed/unglazed. Minimum weight of aluminium doors & windows shall be as follows:

I. Single Glazed Window: (Weights indicated shall be aluminium)

a) Openable

| | | |
|---|---|---|
| Outer Frame | : | Weight 0.70 kg/Rmt |
| Shutter Frame | : | Weight 0.97 kg/Rmt |
| Intermediate Mullion | : | Weight 0.97 kg/Rmt |
| Beading | : | Weight 0.31 kg/Rmt |

Fixing Louvers windows/ventilators

| | | |
|---|---|---|
| Outer Frame | : | Weight 0.46 kg/Rmt |

II. Double Glazed Window

| | | |
|---|---|---|
| Outer Frame | : | Weight 0.72 kg/Rmt |
| Shutter Frame | : | Weight 0.97 kg/Rmt |
| Intermediate Mullion | : | Weight 0.98 kg/Rmt |
| Beading | : | Weight 0.31 kg/Rmt |

III. Sliding Windows

| | | |
|---|---|---|
| Bottom & Top Frame | : | Weight 0.70 kg/m |
| Shutter Frame | : | Weight 0.42 kg/m |
| Interlocking Section | : | Weight 0.47 kg/m |

IV. Aluminium Door

| | | |
|---|---|---|
| Outer Frame | : | Weight 2.508 kg/Rmt |
| Shutter Frame | : | Weight 2.508 kg/Rmt |
| Bottom Stile | : | Weight 2.508 kg/Rmt |

Glazing shall be 5.5wired mm thick glass.as per IS: 2835 for doors and windows.

Glass louvers shall be provided for ventilators with frame weight of 0.46kg/Rmt

29. Openings of the windows & ventilators shall be minimum 25% of the external wall area.

30. Ventilator shall also be provided where height of floor is more than 3m.

31. All windows and ventilators shall have wire mesh. Frame of doors, windows and ventilators shall be of aluminium of standard rolled section. Doors, Windows and Ventilators shall be of size as per schedule to be submitted by the Contractor for approval of Engineer. The minimum size shall be as per below:
Door of opening size 1.2m x 2.1m
Door of opening size 0.75m x 2.1m for toilets
Glazed windows of minimum size 1.2m x 1.2m
Ventilators of minimum size 0.6m x 0.6m

32. Rolling shutters shall be made of 80 x 1.25 mm MS laths. Rolling shutter shall be of minimum size 3m wide x 3.0m high. Rolling shutter shall be provided in MCC cum panel room, chlorine tonner shed, and centrifuge at entry and exit of the pump house for access to pumps, motors, valves, panels, blowers and as wherever required. Up to 3m height mechanical operated rolling shutter shall be provided and If the height is more than 3m, then electrically operated rolling shutter shall be provided.

33. All structural steel members shall be painted with two coats of enamel paint over one shop and one field coat of red oxide zinc chrome primer. All concrete channels and ducts used for conveying liquid shall have inside finish of type F2. The width of concrete channels shall not be less than 500 mm. All open channels shall be provided with Aluminium hand railings.

34. All exposed surface of inserts embedded in concrete shall be painted with two coats of enamel paint over one coat of Red Oxide Zinc Chrome Primer. Surface in contact with concrete shall not be painted.

35. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factory Act. It shall not be less than 150mm.

36. All structures in the ISPS and Treatment plant units shall be provided with appropriate sign boards indicating the function of the units involved written in Kannada and English Languages.

37. Wherever equipment and machinery are to be moved for inspection, servicing, replacement etc., suitable movable gantry of minimum capacity of 2 tonnes or more as required shall be provided with monorail and operating equipment.

38. The design of buildings shall reflect the climatic conditions existing on site. Process buildings shall as far as is possible permit the entry of natural light, and the use of glazed panelling shall be kept to a minimum and preference given to wall openings protected by weather canopies.

39. Emergency exit doorways shall be provided from all buildings in order to comply with local and international regulations. Stairways and paved areas shall be provided at the exit points.

40. Toilet blocks in process buildings and control blocks shall be provided with a sink with two drinking water taps of 20 mm size with adequate inlet and outlet connections.

41. The side walls of buildings shall, except those used for storage and handling of Chlorine gas comprise at least 15% ventilated brickwork or louvers. Ventilated brickwork or louvers shall not be used where the ingress of driven rain could affect plant or stored materials. Flat roofed areas shall be provided with roof vents to further encourage a through flow of air.

42. All the walkways shall have minimum 1.0 m width and shall be secured with Handrails and toe guards.

43. Suitable River flow training systems/Flow diversion to be adopted at required locations/places in compliance with relevant Geotechnical Investigation Report recommendations as applicable.

44. All concrete structures in contact with sewage and/or sludge shall be provided with full interior corrosion protection linings and/or coatings of appropriate material and thickness to be approved by Employer. For Aeration Basins, interior lining shall extend from the top of wall down to 1.0 meter below the lowest operating water level.

45. For structures containing water or process liquid, the top of the wall shall be at least 0.5m higher than the maximum water surface level calculated at high flood level and peak plant flow. The top level of internal plant roads and approaches shall be at least 1.0 m above the site High Flood Level.

46. If the High flood level is more than Ground Level, then road shall be constructed on the Earthen Embankments/Engineered Embankment. Earthen Embankments/ Engineered Embankment shall be constructed with side slope of at least 2 horizontal to 1 vertical. Stone pitching shall be provided at both sides of the embankment as per IS: 8237. Top width of embankment shall be taken as 6.0m. Top level of embankment shall be 1.0 m above high flood level. The excavated earth from the plant can be used for earthern embankment construction if suitable and if required extra earth can be borrowed from the borrow pit as approved by Engineer.

47. Anti-termite treatment, under and around the column pits, walls, trenches, basement excavation, top surface of the plinth filling, junction of wall and floor, along the external perimeter of building, expansion joints, over the top surface of consolidated earth on which apron is to be laid,

surrounding of pipes & conduits, with chloropyriphos emulsifiable concentrates of 20% concentration is to be provided for this only plinth area of the building at ground floor only shall be measured.

48. Engineered Embankment for plant structure in Swampy/Water logged areas shall be considering in compliance with relevant Geotechnical Investigation Report recommendations as applicable.

49. All requirements for Engineered Embankment and all other associated works connected to this system (i.e. all controlled filling requirements, type & suitability of materials, methodologies testing, protective system, aprons, proper slopes, stability, specifications, quality control, and all other requirements pertaining to this system of works, etc.,) shall be considered in compliance with relevant geotechnical investigation report recommendation as applicable. Also, to enlist the service of an experience and specialized agency for all related design aspect consideration, equipment specifications, and implementation methodology, etc., as an advice for the same.

## 1.23 Roadways, Pathways & Hard standings

A comprehensive network of roadways with turning bays as required for access, removal of plant and equipment, removal of sludge, grit etc. From site shall be provided around the treatment plant to link in with the existing road network and permit access to the plant for necessary maintenance, delivery of consumables and personnel access.

All roads shall be designed and constructed as per the specifications and as per site requirements. Bidder shall provide minimum 3.5 m wide internal roads with 1.50m shoulder on one side, which shall be utilised for future expansion of the internal road and 5.0 m wide approach road shall be provided until STP Entry gate from the nearby Main Road or Highway. 1.5 m shoulder on both sides of the road shall be provided as per site requirement and as directed.

The road works shall be designed and constructed as per MORTH guidelines and specifications. The minimum road layers shall consist of granular sub base, sub grade, wet mix macadam (2 layers with compacted thickness of 150 mm), semi dense bituminous concrete, bituminous macadam and Bituminous concrete as per the design requirements All roads shall be provided with drainage and shall be constructed to prevent standing water.

Paved pedestrian access ways shall be constructed to provide a network of logical routes interlinking plant areas. Damage to any existing roads on account of their use by the Contractor shall be made good to the satisfaction of the Engineer.

Hard standing areas with shading facility shall be provided to permit the parking of vehicles involved in the delivery of consumables from blocking site roadways during unloading or loading. The road system shall be designed such

that vehicles involved in the delivery of consumables can follow a continuous route through the works and out again without the need to reverse or carryout complicated maneuvers in order to exit the site.

## 1.24 Site Drainage

The Contractor shall provide a site drainage system. The system shall comprise of the following:

- Storm Water Drainage
- Foul Drainage
- Process Drainage

### 1.24.1 Storm Water Drainage

For the major storm water drains passing besides or within the STP complex shall be designed as per CPHEEO requirements considering the contributing catchment area. Necessary cross drainage works shall be provided for road crossing etc. If the existing storm water drain is passing through the center of the STP area, the storm water drainage alignment shall be diverted along the edge of the STP complex area for proper usage of the STP area.

For the internal storm water drains adjacent to the existing and proposed roads (under the contract) shall be sized for a rainfall intensity of 50 mm/hr, allowing for 100% run off. The drains adjacent to roads for walls and floor shall be in RCC M 20 grade. The floor is to be laid over a minimum thickness of 10 cm thick 1:3:6 PCC bed and the drain is to be covered with M 25 grade RCC slab. The minimum width of the drain shall be 300 mm. The storm water drainage system shall also be designed to cater the run off from the existing plot areas and structures, if necessary depending upon the site topography.

### 1.24.2 Foul Drainage

The foul drainage system shall accept discharge from toilets, washrooms, offices and the laboratory. The foul drainage system shall discharge to a septic tank of appropriate volume or to the existing foul drainage system.

## 1.25 Flood Protection Works

An Earthen Embankment with minimum slope of at least 2 horizontal to 1 vertical on both sides has to be constructed as required. Slope of the embankment shall be decided as per the soil properties. Stone pitching shall be provided on the both the sides of the embankment as per IS: 8237. Top width of the embankment shall be at least 3.5m. Top level of the embankment shall be 587.5. Embankment shall be designed as per IS: 12094.

Earth for the embankment & site grading shall be made available from the contract package of the same project. Excavated earth from Reservoir and pumping station proposed to be constructed as per the contract shall be used for

the construction of earthen embankment and site grading. If required, excavated earth from treatment plant shall also be used for earthen embankment and site grading. The embankment shall be constructed with the available material as per the standard specification.

GI chain link fencing shall be 2.75 m high above finished ground level with top 0.75 metre of barbed wire confirming to IS 278. The fencing shall include fabric mesh confirming to IS 2721, top and bottom runner wires, vertical posts, GI strap at every vertical post, etc, all as approved by the Engineer.

### 1.26 Cable and Pipe work Trenches

Cable and pipe work trenches shall generally be constructed in reinforced concrete.

Trenches within the buildings or Plant areas shall be covered with M20 precast R.C.C covers. The trenches shall be suitably sloped to drain rain water. All uncovered openings shall be protected with hand railing

Layout of trenches outside the buildings shall allow space for construction of future trenches where necessary with due consideration for planning for future developments. This aspect shall be brought to the notice of the Engineer while planning the works.

### 1.27 Pipes and Ducts

R.C.C ducts for drainage shall have minimum 1 meter over precast cover (M20 concrete, Heavy duty) while laid under roads. Access shafts of size not less than 600 mm x 1000 mm shall be provided.

All drains (except storm water drains adjacent to roads) shall be covered with precast RCC slab and designed structurally for appropriate loads.

### 1.28 Precast Compound Wall and Gate

Compound wall shall consist of RC precast slab panels (M25) with minimum 60m thickness BWSSB logo, RC post at regular intervals including plinth beam as supports for the panels and necessary RC foundation system for the same along with barbed wire stretched between MS angles fixing at the top of the precast panels with necessary fixtures etc.,

All structural designs and Specifications shall confirm to relevant codal provisions.

An Indicative Typical Boundary wall profile of TYPE-I & TYPE-II is enclosed as reference for the same. (Refer to Sketch -1, appended in Page 32 & 33)

Each proposed ISPS and Sewage Treatment plant shall have one main gate to access the plant irrespective of existing gate at the premises of existing plant

site. Minimum clear width of main gate shall be 6m. Main gate shall have 1.5m wide wicket gate. Gates shall have as external framework of GI pipes and internal framework of MS flats. Gate shall be fixed on RCC columns. The design and pattern of gate with drawing shall be submitted for approval of the Engineer. The gate shall have all necessary hinges, locking arrangement, rolling arrangement and painting complete, as approved by the Engineer.

## 1.29 Retaining wall

1. Retaining wall shall be RCC with minimum M25 grade of concrete. Wall foundation shall be placed on virgin soil and not on backfill soil. Foundation shall extend to a depth of at least 1.0 meter below finished ground level or as required

2. Expansion joints shall be provided in the retaining wall.

3. In retaining walls, 100mm dia weep holes shall be provided at 1m vertically and horizontally. The lowest weep hole shall be about 30cm above the ground level. All weep holes shall be surrounded by loose stones and shall have sufficient fall to drain out the water quickly.

## 1.30 Landscaping

The site shall be landscaped once the Works are substantially complete. Landscaping area shall be marked in layout plan.

Landscaping shall include planting of suitable trees and development of grassed areas. Landscaping in general shall meet ecological and environmental conditions of the site. Road widths shall determine the size of the tree height and spread to be selected for planting. Trees suitable for local conditions shall be selected. Medicinal and fruit trees shall be avoided. Landscaping shall be maintained in good condition till the completion of contract. Area for landscaping shall be equal to total area of project site minus area for the ISPS/Treatment plant units and the area required for roads, sidewalks and drains.

### 1.30.1. Tree Planting

Pits dug a few days in advance of actual planting shall be allowed to weather and be filled with top soil mixed with manure. Size of the pit shall be as per standard requirement. Only one tree shall be planted in each pit. A guard made of bamboo with wire mesh or bricks or M.S. rings as approved by Engineer shall be provided. A minimum of 100 trees shall be planted in each STP layout or any other suitable location shown by Engineer. A minimum of 20 trees shall be planted in each ISPS site layout or any other suitable location shown by Engineer. All trees shall be maintained upto the end of O & M period.

## 1.31 Hydraulic Testing of Liquid Retaining Structure

In addition to the structural test of structures as applicable, the liquid retaining structures shall also be tested for water tightness test at full supply level as described in clauses 12.1,12.1.1, 12.1.2 and 12.1.3 of latest version of IS 3370 (Part I).

On completion of the structure and before its commissioning, the contractor shall carry out a water tightness test for the maximum water head condition i.e. with the water standing at Full Supply Level (FSL) of the structure. This test shall be carried out preferably in dry season in accordance with the procedure given below:

The water tightness test shall be carried out when the construction of liquid retaining structure is completed and when it is possible to fill the structure and ensure that uniform settlement of the structure as a whole or as directed by the Engineer. Before the filling operations are started the structure shall be inspected by the Engineer and the Contractor's Representative and the condition of surfaces of walls, contraction joints shall be noted and it shall be ensured that the jointing material filled in the joint is in position and all openings are closed. The Contractor shall make necessary arrangement for ventilation and lighting of the structure by way of floodlights, circulators etc. for carrying out proper inspection of the surfaces and inner conditions if so desired by the Employer. Records of leakages starting at different levels of water in the reservoir, if any, shall be kept.

The liquid retaining structure once filled shall be allowed to remain so for a period of seven days before any readings of drop in water level are recorded. The level of the water shall be recorded against the subsequent intervals of 24 hours over a period of seven days. The total drop in surface level over a period of seven days shall be taken as an indication of the water tightness of the structure, which for all practical purposes shall not exceed 20 mm excluding evaporation loss. Also there shall be no indications of the leakages around the opening or on the walls.

If the structure does not satisfy the condition of test and the daily drop in water level is decreasing, the period of test may be extended for a further period of seven days and it the specified limit is then reached the structure may be considered as satisfactory.

The external faces of structure shall not show any signs of leakage and shall remain apparently dry over the period of observation of seven days after allowing a seven day period for absorption after filling.

In case the drop in level exceeds the permissible level limit and signs of leakage with the stipulated period of test, the Contractor shall carry out such additional works and adopt such measures as may be directed by the Engineer to reduce the leakage within the permissible limits. The entire rectification work that shall be carried out in this connection shall be at the Contractor's cost. Contractor shall have to make arrangement for filling emptying the structure at his own cost.

If the test results are unsatisfactory, the Contractor shall ascertain the cause and make all necessary repairs and repeat the liquid retaining structures test procedures, at his own cost. Should the re-test results still be unsatisfactory after the repairs, the structure shall be condemned and the Contractor shall dismantle and reconstruct the structure, to the original specification, at his own cost.

During testing and during defect liability period the impression marks created due to seepage shall be rectified and made good.

No separate payment shall be made for water tightness test and the cost thereof shall deem to be covered in the rates quoted for the works.

## 1.32 Non-Destructive Testing of RCC Structures

Non-Destructive Testing (NDT) shall be carried out as per latest IS: 13311 codes as per the instruction given by Employer.

Commonly used NDT to find quality, structural integrity and soundness of insitu concrete are:

1. Rebound Hammer Test is a qualitative field test method to measure surface hardness of concrete to find insitu concrete strength.

2. Ultrasonic Pulse Velocity (UPV) Test is a qualitative field test method for determination of discontinuities, cracks and depth of cracks of concrete.

3. Core cutting/Sampling Test is a field cum lab test for assessment of strength, density, texture and permeability of concrete.

4. Radiography Test for taking photographs showing details inside of concrete member, where other NDT methods are not suitable.

5. Impact Echo Test is a filed/laboratory test method to detect hidden damage and its extent.

In case there is any distress in concrete during the execution, Engineer can take decision to go for NDT on the RCC construction before taking any action. Contractor shall conduct NDT tests on his own cost.

## 1.33 Specification for Anti-Corrosive Internal Coating/Lining protection of Concrete Surfaces

Application limits of Anti-Corrosion Internal Coating/Lining for Concrete Surfaces:

1. All units upstream of secondary treatment units shall have to be provided with internal coating/lining for the full internal surface area (Walls and base slab).

2. For the units - Anaerobic Zone, Anoxic Zones, Aeration Zones and Aeration Basin Effluent Channels, internal coating/lining shall be provided on the walls only from the top of the structure to 1.0 m below the lowest operating liquid level

3. For the units handling the solids part such as Sludge Thickener, and all other units, internal lining shall to be provided for the entire internal surface area.

Contractor shall adopt any one of the following materials for internal coating/lining which should be grey coloured, **solvent free**, machine sprayed, resistant to water and chemicals, good bond between concrete surface and lining/coating material and submit his methodology for approval of Engineer. no signs of swelling, scratches or peeling of coating specimen shall be observed after application of coating or lining.

**Concrete Structure-** Surfaces must be clean, dry and free from curing compounds, laitance, releasing compounds, oil, grease, dirt, chalk, or previously applied coatings. Laitance must, therefore, be removed by sweep blasting or other means prior to coatings application. Ensure that the concrete is sufficiently dry to receive coatings; use a moisture meter. The 6% maximum moisture content shall be permissible. a minimum surface thickness of 500 microns is recommended.

**Steel Structures-** All surfaces to be coated must be clean and free from dust, grease, oil or loose material. a minimum surface profile of 50- 75 microns is recommended.

Below are some of the vendor products accepted. However, the process and application requirements shall be matched and got approved from the engineer in charge before start of work for the products and vendors mentioned below. Also, if any new material and vendor can meet the process requirements, as stated above, the Engineer in charge shall approve the material specifications by the manufacturer.

| Sl No | Approved Vendor | Approved/Appropriate product |
|---|---|---|
| 1 | Sika India Pvt. Ltd. | Intertol Poxitor |
| 2 | STP Limited | Shalipoxy – CTE 406 |
| 3 | BASF Construction chemicals | MasterSeal – 7000CR |
| 4 | Fosroc | Nitocote NT402 |
| 5 | International - PC | Interzone 954 |

## 1.34 Rain Water Harvesting System

The Rain water harvesting for the proposed STP & ISPS complex shall be carried out in line with the regulatory guidelines specified by Bangalore Water Supply and Sewerage Board (BWSSB) & GOK norms.

### 1.34.1 Components of the Rain water Harvesting scheme

1. Rainwater harvesting carried out for enriching the groundwater resources essentially consist
    a) Common collection tank and
    b) Pipeline(s)

2. Following are the main components proposed for the roof water harvesting system at the STP including their location in the project area:
    a) Rainwater pipes from the roofs of all the building.
    b) First flush piping system.
    c) Storm water drains adjoining the roads of the plant.

### 1.34.2 Rainwater harvesting system for buildings

The runoff from the roof top of all buildings shall be collected to a RCC sump at suitable location in the plan area with a minimum water retaining capacity of 40Cum. The minimum height of the sump shall not be less than 1.8m and 0.3 m free board The runoff shall pass through suitable filters for removal of impurities. A suitable submersible pump shall be provided in the sump for supplying water to gardening and flushing the toilets, to reduce use of potable water.

### 1.34.3 Rainwater harvesting system for plant area

The runoff from internal road side drain and major plant are shall be drained to rainwater harvesting structures for ground water recharge.

## 1.35 Well Sinking

The Well Sinking shall be proposed for Wet wells, where the surrounding area is in water logged condition or water table is up to FGL and it is difficult for open foundations. Well Sinking shall be done as per specifications mentioned in Part-10A and shall meet the requirements as mentioned in Part-1, additional scope details for civil works under works –A.

## 1.36 Pile Foundations

### 1.37.1 General

The design of Pile foundation shall be in accordance with IS: 2911- Bored cast in-situ piles with minimum grade of M30. Where it is anticipated to fill the low

lying STP/ISPS areas to a depth of 2m to 5m (Engineered fill), waterlogged areas, soft soils, low SBC areas, it is practically difficult to provide shallow foundation, hence pile foundation is proposed in those areas. The requirement of Pile Foundations is mentioned in Part-1, additional scope details for civil works under works-A. Hence the bidder shall follow the same philosophy for pile foundations.

Where site filling is envisaged, In such cases the proposed site shall be filled and compacted up to the FGL with proper consolidation and site filling methodology and later the pile construction activities shall be taken up. Below points are to be taken care

i. Before the actual construction begins, pile load tests must be made to verify the design values, the foundation design must be revised according to the test results.

ii. Piles in sands are driven to the maximum possible depth because pile load is proportional to square of the length. In clayey soils, increased length does not increase the capacity as rapidly as in sandy soils. In clays the length is determined by block failure criterion. Provision of a spread or bulb at the bottom increases the pile load considerably.

iii. A minimum of three piles are required under a column in order to resist all the column loads and moments acting on it. If one or two piles are provided under a column, the grade beams have to be provided in one or more directions which have to be designed to resist fully column basements since piles shall resist the vertical loads only.

### 1.37.2 Compaction methodology

The Engineered fill shall be placed in layers of each lift not exceeding 200mm thick with appropriate confinement or self-stabilising slope at the edges. Rollers shall be adopted in order to achieve 97 % modified proctor density, with data for modified proctor density to be initially obtained from laboratory testing of fill material. The number of passes and rollers shall be as suggested in IS-4701(based on soil type). The Quality control tests shall be adopted to verify the achievement of required level of compaction prior to giving clearance for laying next layer. The soil intended for filling shall not have excessive presence of gravels, cobbles/silts and clays.

## SECTION – 1

## EARTHWORK EXCAVATION

## 1.1 Clearing site of large trees, structures etc.

This shall include the removal of large trees, stumps, structures, services such as cables, water supply, sewerage, storm water drains etc. or parts thereof lying along the alignment of sewer. The contractor should inform the Engineer before removing trees, structures, other services and structures etc. well in advance. Large trees and other valuables are the property of the Government and it should be properly stacked along the side of the road and conveyed to the place as per directions of the departmental Engineer. The cutting of trees or demolitions of structure are done in such a way that it should not disturb the traffic and pedestrians.

## 1.2 Removal of Top Soil, Shrubs and Other Vegetation

The work has to be tackled in between two adjacent manholes only. All shrubs, vegetation and other plants shall be removed and cleared from the selected stretch of the site. All debris and unsuitable material up to a depth of 30 cm between ground level and road level shall be removed. All debris and unsuitable material shall be carted away from the site as per the direction of departmental engineer. The clearing and grubbing for trees upto 300 mm girth shall be removed. No separate payment shall be paid towards the above works and work includes loading, unloading, carting the material to a site selected by the contractor, disposal of unserviceable materials at his own cost.

## 1.3 General

Excavation shall be required to be done for the following works:

a) Excavations for underground sewer lines & pumping mains and other works as directed
b) Excavations for sewer lines below storm water drains
c) Excavations for manholes, footings, pedestals and other works as required etc.
d) No separate payment shall be made for removal of shrubs, grass, large and small bushes, trees, stumps and stems of trees cut up to 300 mm girth, fencing including posts and gates and rate for the same shall be deemed to be included in the other pay items of BOQ

## 1.4 Preparatory Work, Sight-rails and Boning Staves

The centre line of the trench is first marked out on the ground duly driving pegs at convenient intervals. Before commencement of earth work excavation, levels shall be taken along the centre line of the proposed sewer at intervals of say 10 m and at the manhole locations. A longitudinal section (LS) of the profile of the ground surface showing the proposed sewer, indicating the gradients and giving the invert levels of the sewer as well as the manholes available at the tender stage shall be updated based on Contractors re-confirmatory survey and approved by the Engineer before taking up the work.

The width of the trench to be excavated is marked on both sides of the centre line and excavation lines cut out.

Two wooden posts 100 mm x 100 mm x 1800 mm high shall be firmly, erected/fixed across the centre line i.e on either side at nearly equal distance, from the centre line and sufficiently clear of all intended excavation such that the poles/posts are not disturbed during the course of execution of the work. These posts are so arranged and fixed that a sight-rail when fixed at a level against these posts shall cross the centre line of sewer or centre of the manhole, as the case may be.

The sight-rail made from 250 mm wide x 40 mm thick wooden planks shall be screwed to the poles. The sight-rails shall be truly horizontal. The centre line of the sewer shall be marked on the sight-rail by fixing a nail or otherwise as determined by the Engineer. The sight-rails may be fixed about 1.25 m above the ground, which is convenient distance for sighting by a leveling instrument. The sight-rails have to be so fixed that when a line sighted along the top edge of the sight-rails shall represent the true fall or gradient of the proposed sewer. This gradient is transferred below the ground level by means of boning-rod. Boning is carried out between the sight-rails with the help of a cord or a rope extended from nail to nail fixed on the sight-rails.

Boning rods with cross section 75 x 50 mm of various lengths shall be prepared with wood. Each length shall be a certain number of meters and shall have fixed tee-head. (A cross piece of 450x 100 mm is to be fixed with nails at the top of the boning rod so as to form shape like a Tee-square) and a cross piece about 300 mm long fixed at the bottom of the boning staff. The distance between the top of Tee head and the cross piece shall depend upon the site requirements viz, dia of pipe, depth of cutting, level of sight-rail, designed level of sewer, etc. The boning rod must be marked on two sides to indicate its full length. According to the circumstances of each case, a suitable length of boning rod, duly fixing the cross piece, will be determined upon the reduced level of the invert of pipe at each sight-rail.

The sight-rail and vertical posts shall be perfectly square and planed smooth on all sides and edges. This arrangement of erecting poles with sight-rail shall be done at suitable intervals depending on the site requirements, as directed by the Engineer. The posts and rails must in no case be removed until the trench is excavated, the pipes are laid and permission given to proceed with the filling in.

## 1.5 Probing Pits

Before starting the excavation of trenches, the contractor shall dig probing pits of size 1 m x 1 m and 1.5 m deep including road cutting at every 100 m interval along the alignment to accurately locate and determine the position of existing utilities and obstructions. The contractor shall refill the probing pits in layers of 15 cm with excavated earth up to the original ground level. In all cases the probing pits are to be excavated in accordance with the specification for excavation, refilling etc. No separate payment will be made for these probing pits and shall be deemed to be included in other pay items of the BOQ.

## 1.6 Utilities Protection

All utilities within the site, such as water, storm and sewage mains, shall be ascertained by probing pit results at various intervals or as required.
All utility lines and structures, whether indicated on the drawings or not, which are to remain in service shall be protected by the contractor from any damage likely to result from his operations. Any damage to any utility resulting from the contractor's operations shall be repaired at the contractor's expense.

## 1.7 Pavement Removal

The contractor must inform the Engineer before the starting of work well in advance so that it can be communicated to other concerned departments. The contractor must provide and maintain proper and efficient traffic control system such as safety lamps, sign boards etc. operating day and night for the full duration of work. The BWSSB shall not be responsible under any circumstances for any mishappenings therefore. For the purpose of payment of removal of pavement, steel tapes are to be used and the measurement shall be taken jointly by the Engineer's representative and contractor or his representative. The maximum width of trench excavation shall as per relevant Indian standards or outer dia of the pipe + 0.3 m whichever is lower and only such widths shall be taken into account for computing quantities for payment. For other elements of work such as manholes, making cross connections, fixing other appurtenances etc. the engineer shall prescribe the dimensions for removal of pavement from time to time.

## 1.8 Maintenance of Traffic And Closing of Streets

The work shall be carried out in such a manner which will cause the least interruption to traffic, and the road/street may be closed in such a manner that it causes the least interruption to traffic, Where it is necessary for traffic to cross open trenches, suitable bridges shall be provided. Suitable signs indicating that a street is closed shall be placed and necessary detour signs for the proper maintenance of traffic shall be provided.

## 1.9 Soil Investigations

Soil analysis reports of proposed sewer alignment are available with BWSSB office. Additional soil tests if necessary shall be carried out along the alignment and the soil boring logs shall be prepared by the contractor at his own cost. Where off-site materials have to be used, the contractor shall, if the Engineer desires make available certified soil test reports including information regarding sieve analysis, plastic limit, liquid limit, maximum density, optimum moisture content etc. from an approved testing laboratory.

## 1.10 Classification

The excavation work shall be classified into the following categories:

**Sewer lines, Manholes, pedestals and other works.**

i) All soils: Loamy, clayey soils like BC soils, red earth, ordinary gravels, hard gravel, mixture of gravel and soft disintegrated rock, ordinary gravel, stony earth and earth mixed with boulders of 30 cms size and exclusive of disintegrated rock.

ii) Disintegrated rock, soft rock, soft shale, and medium hard rock comprising of lime stone , sand stone, hard shale schiest, fissured rock or soft rock or conglomerate rock, to be removed by pick axes and crow bars, wedges and hammers with some difficulty including all types of laterite excluding hard rock

iii) Hard rock to be removed only by chiseling and benching/breaker, diamond rope cutting or as directed by the engineer.

## 1.11 Trench Excavation

### General

Trench excavation means excavation of trenches into which the pipe is to be laid. The line and levels of trenches shall be as shown on the drawings or as may be directed by the Engineer. Before commencing trench excavation, the route of the trenches shall be pegged out accurately and the natural ground levels shall be agreed with the Engineer.

## 1.12 Width of Trench

The width of trenches measured at the crown of the pipe shall permit adequate working space. The trenches shall be widened at sockets and other structures as may be found necessary. The widths to be adopted are shown in respective drawings. If the widths of actual excavation are more than the specified, it has to be made by the contractor with no separate payment. Care should be taken to avoid excessive trench widths and thereby increasing the load on the pipes. The maximum width of trench excavation shall as per relevant Indian standards for pipe laying or outer dia of the pipe + 0.3 m whichever is lower and only such widths shall be taken into account for computing quantities for payment. However, the minimum width of the trench shall be 600 mm.

## 1.13 Depth of Excavation of Trench

The depths for the trenches will be calculated from the surface to the bed of the pipes and in case when a layer of bedding is to be placed below the pipe line, the depth to the bottom of the bedding will be paid. The depth of excavation for manholes shall be measured from the surface of the existing ground level to the bottom of foundation. No payment will be given beyond this depth.

### 1.14 Maximum Length of Open Trench

The stretch of work to be tackled shall be limited to two adjacent manholes. However, the Engineer may permit only reasonable trench excavation in advance of the lengths between two adjacent manholes to ensure laying and jointing of pipes can reasonably be expected to be completed and the trench refilled not attended later than 3 days after excavation of the trench. The Contractor will not be permitted to keep trenches open for unduly long periods, creating public hazards. The Engineer's decision in this respect shall be final.

### 1.15 Trench Sides

Loose boulders shall be removed from the sides of the trenches before allowing workmen into the excavation, and the trench sides shall be stabilized with screening or other methods approved by the Engineer. Trench slopes shall be kept moist where necessary to prevent local sliding as ordered by the Engineer.

### 1.16 Widening Trench at Joints, etc.

Any widening or deepening of the trench, whether in ordinary soil or rock, necessary to accommodate curves, joints or bends as shown on the drawings or ordered by the Engineer shall be carried out by the contractor.

### 1.17 Over-excavation of trench bottoms

All excavation carried below the grades shown on drawings, shall be refilled with compacted bedding material at the Contractor's expense.

### 1.18 Excavated material

The material from the excavation shall be deposited on either side of the trench leaving clear berm on one side at least 40 cm wide or at such further distance from the edges of the trench as may be necessary to prevent the weight of materials from causing the side of the trench to slip or fall, or at such a distance and such a manner as to avoid covering fire-hydrants, sluice valves, manhole covers and the like and so as to avoid any wall or structure or causing inconvenience to the public or other persons or otherwise as the engineer may direct, till it is carted away.

The excavated soil should be so placed and handled as not to inconvenience the usual traffic, till it is carted away. The contractor should also provide necessary bridging over the excavated trenches for the house-holders and pedestrians to cross over and vehicular crossings if and where required at no extra cost, if the Engineer decides that there is no hindrance to traffic due to not carting away the excavated earth, he will give instructions to that effect..

The manhole frames and covers from the existing manholes shall be carefully removed and stored in a suitable place away from the trenches. The contractor should not break the manhole frames and covers while removing. The contractor is responsible for the safety of manhole frames and covers.

## 1.19 Pipe Bedding

**i) Granular Bedding**

The bed of trenches shall be prepared as per drawing. Sand used for back fill shall be natural sand (free from cinders, ashes, slag, refuse, organic materials, boulders, rocks or stones) graded from fine to coarse or manufactures sand as per BOQ & contract specifications. The total weight of clay in it shall not exceed 10%. All materials shall pass through a sieve of aperture size 6.30 mm.

**ii) Gravel/Murram Bedding**

The bed of the trenches shall be prepared as per drawings. The approved granular material shall be of size less than 25mm (murrum) and work shall include watering and consolidation by punners etc., complete with all lead and lifts, as per specification and as directed by the Engineer complete

**iii) Stone dust or quarry dust Bedding**

The bed of the trenches shall be prepared as per drawings**.** Bedding or Back filling shall be using approved stone dust/quarry dust of size not exceeding 5.6mm for the pipe line trenches and work shall include watering and consolidation to 95% proctor density etc., complete with all lead and lifts as per specification and as directed by the Engineer complete

**iv) Concrete Bedding**

This type of bedding is as per the drawing appended with the tender document, and is to be provided at locations shown in drawings or as specified by the Engineer. A concrete bedding as per BOQ provisions shall be provided mostly in weak strata and in storm water drains. The concrete work related to this specification is detailed in the specifications of concrete and allied works.

In case of sewers laying in storm water channels, the pipe shall be encased with cement concrete/reinforced cement concrete of grade as per BOQ provision with a minimum thickness of 150 mm all around or as per bedding drawing. If the clear distance between drain bed and pipe top is more than one meter then concrete bedding as directed by the Engineer shall be done.

## 1.20 Trench excavation in hard rock

If any material which in the opinion of the Contractor can be classified as hard rock is encountered, he shall immediately inform the Engineer and the level, extent and description of the material encountered shall be measured jointly and recorded before excavation.

Only such proportion of material notified and measured which is certified by the Engineer as "rock", shall be paid for as rock excavation.

Excavation for trenches in rock shall be so carried out such that the clearance between the pipe, when laid in position and the sides and trench bottom shall be kept to the minimum limits necessary to provide for specified thickness of bedding, and surround to the pipe as specified. Excavation outside the specified limits shall not be paid for and any additional expenses incurred in providing additional strength to the pipe to overcome the increased trench loads on account of increased width shall be at the Contractor's expenses. The rock thus excavated shall be auctioned as directed by Employer/Engineer as per GOK procedures and the auctioned amount shall be remitted to the Employer/Engineer.

### 1.21 Excavation for appurtenances

Excavation in trenches for foundation anchor blocks, pedestals etc. shall be as per the plan or as directed by the Engineer. The dimensions of the excavation shall be measured as the projection in plan of the outermost edges of the structure.

### 1.22 Pumping sewage or diversion by gravity and dewatering

General
The works included in this Section are as follows:

1) Provision of all labour, equipment, materials etc. to ensure a safe and dewatered condition in all areas in which the work in this contract are to be executed.
2) Continuous operation of the dewatering systems is required to complete all portions of the works where dewatering and pumping of sewage is necessary to prevent inflow, collection of surface water or ground water, or sewage or to protect adjacent properties or constructions from damage resulting from a rise or fall of ground water levels or sewage.
3) Removal of the equipment when no longer required.

### 1.23 Pumping out water and dewatering

The Contractor shall provide and work at his own cost, all pumps, engines and machinery requisite to keep the trenches for the sewers or foundations and all other excavations clear of water, whether subsoil water, storm water, sewage, leakage from tanks, wells, drains, sewers, water mains or pipes etc., so that there may be no accumulations of such water and that no setting out may be done, no masonry may be laid, no concrete deposited, no joints made and no measurements taken in water.

The pumping shall be continued so long after execution of any portion of the work and repeated so after as the Engineer may consider necessary. The pumps and power applied must be such as the Engineer may consider necessary for

the work to set. The pumps and power applied must be such as the Engineer may determine to be sufficient to any particular time so that he may stop the work altogether until he is satisfied and also impose a fine upon the contractor

The Contractor shall be responsible for the adequate pumping, drainage and bailing out of water from the excavation with all rates of recuperations. Dewatering shall be either continuous or intermittent using method approved by the Engineer. The method of dewatering shall depend on site condition should be furnished by the Contractor and approved by the Engineer. The method of dewatering shall be either sump pumping or well point dewatering. The effectiveness of each method will depend upon the nature of the soil, the proportions of the trench and degree of lowering required. Pumping test may be necessary to determine which method is suitable. If sump pumping is not practicable other control methods shall be considered and should be approved by the Engineer. The trenches should be kept dry till the completion of work, which includes excavation, pipeline laying, jointing, testing and commissioning and backfilling. Precaution should be taken against the flotation of the pipes. The Contractor shall conduct ground studies if found necessary and the cost for such studies have to borne by the Contractor himself.

The Contractor shall be responsible for the adequate pumping, drainage and bailing out of water met due to all causes from the excavation for laying sewer pipe lines and all types of constructions. In case of failure to make such provisions or any other provisions, which may result in unsuitable sub-grade conditions, the Contractor shall replace and repair the sub-grade as directed to the satisfaction of the Engineer, at his own cost and responsibility.

Should the Contractor select to use a gravel sub-grade with or without unjointed pipes with the gravel layers to facilitate flow of water to pumps or other points of disposal, such gravel sub grade with or without conveying pipes shall not be measured or paid as an extra item and rate for the same shall be deemed to be included in the other pay items of BOQ.

### 1.23.1 Sump pumping

This method may be used in highly and moderately permeable soils such as gravels, sand and gravel mixtures. This method is simple and cheap to install and used with watertight trench sheeting to limit the volume of flow. To prevent the boiling in the bottom of the trench the following precaution should be taken.
Drive sheeting deeper to lengthen drainage path;
Use open pipe surrounded in gravel as a sump;
Move the sump to one side of the trench;
To prevent removal of fines from soil causing loss of strength in the soil and undermining of the trench bottom and side support, surround suction inlet with protected graded filter;
Increase flow rate through the soil by using open pipe surrounded with gravel.

The delivery side of the pump should be monitored by taking samples of water and checking the proportion of fines being removed. If fines are being

continuously withdrawn or there are signs of trench instability, sump pumping should be stopped and alternative methods to the considered.

### 1.23.2 Well pointing

In this method well points are installed at regular intervals on one or both sides of the trench and linked parallel to a header main connected to a pump. Well points are usually installed at 0.6 to 2.0m centre to centre by jetting them in. In ground with dense layers or cobbles & boulders it may be necessary to pre bore the layers. The efficiency of the well points is increased by sanding in the well point and riser using a column of sharp sand. This method has an advantage of drawing water away from the trench and in suitable conditions is effective in lowering the water by 4 to 6m below excavation level. It will also reduce the hydrostatic heads on the trench support system. Its greatest use in sand, the heavy flows impermeable ground, such as gravels, means that the well points have to be so close together that the method becomes impractical. In clays the rate of seepage is too small for the system to be properly effective. Silts can be stabilized in certain conditions by using special procedures.

The well pointing shall be either single sided well point or double sided well point. For higher depths double sided well point with multi stage shall be considered. Should the Contractor select to use a gravel sub-grade to facilitate flow of water to pumps or other points of disposal, such gravel sub-grade shall not be measured or paid for as an extra item. Contractor should assess the availability of extra earth required for refilling in case of shortage in any particular reach well before quoting rates. Even in case the Contractor resorts to mechanical excavation, the Contractor should take care of proper refilling, consolidation and disposal of surplus earth.

Disposal of ground water is to be away from the area of influence of the pipe laying area Suitable temporary pipelines are to be laid to existing watercourses. For lowering the sub soil water level for the construction of wet wells the bores have to be installed/jetted at distance between two bores varying from 0.6 to 1.0m depending upon sub strata and the incoming flow of water. The bore should be installed at least 1.0m away from the periphery of the excavated earth. The dewatering includes removal of ground water, springs, seepage water, sullage, sewage, running water, rain water etc., in order to make the trench for pipe line works etc. It is to be noted that contractor can adopt the suitable type of dewatering the keep the trench dry until completion of all sewer laying and testing works.

## 1.24 Keep excavation clear of water

Where ground water/Nallah surface flow is encountered or anticipated the contractor shall provide sufficient pumps to handle the ingress of water and must provide and maintain in working order. Standby pumping units are to be made available and employed in the event of mechanical failure. The contractor must also arrange for night and day operation of the pumps wherever necessary to ensure that the work proceeds at all times.

## 1.25 Barricading, watching, lighting

The parts of the barricading shall be of timber, securely fixed in the ground not more than 2.50 m apart. They shall not be less than 10 cm in diameter and not less than 1.5 m above the surface of the ground. There shall be two rails, one near the top of the posts and the other about 0.50 m above the ground and each shall be of 5 cm to 10 cm in diameter and sufficiently long to run from post to post to which they shall be tied with strong ropes or the work shall be carried out as per BOQ provisions.

The method of projecting rails beyond the posts and tying together where they meet will not be allowed on any account. All along the edges of the excavated trenches, a bund of earth about 1 m high shall be formed when so directed by the Engineer for further protection. Proper provision shall be made for lighting at night and watchmen shall be kept to see that this is properly done and maintained. In addition to the normal lighting arrangements the contractor shall provide, whenever such work is in progress, battery operated blinking lights (6 volts) in the beginning and end of a trench with a view to provide suitable indication to the vehicular traffic. The contractor shall also provide and display special boards printed with fluorescent prints indicating the progress of work along-the road. Further, in all such cases the work may be carried out departmentally at the risk and cost of the contractor. The contractor shall be held responsible for all claims for compensation as a result of accident or injury to person and non-provision of red flags.

The Contractor shall at his own cost provide all notice boards before opening of roads as directed by the Engineer.

Arrangements shall be made by the contractors to direct traffic when work is in progress. No separate payment shall be paid for this item of work.

## 1.26 Refilling trenches

1) With a view to restrict the length of open trenches, on completion of the pipe, laying operations, refilling of trenches shall be started immediately by the contractor. Pipe laying and testing shall follow closely upon the progress of trench excavation and the contractor shall not be permitted unreasonable excessive lengths of trench excavation to remain open while awaiting testing of the pipe line.

2) The trench shall be filled by borrowed gravel or approved material up to at least 30 cm. above the top of pipe, back filling is to be done keeping at least 90 cm. length of pipe open at the joints, for verification of joints for water tightness during testing.

3) Care shall be taken while back filling, not to injure or disturb the pipe. Filling shall be carried out simultaneously on both the sides of the pipes so that unequal pressure does not occur.

4) Walking or working on the completed pipeline shall not be permitted unless the trench has been filled to a height of at least 30 cm over the top of the pipe except as may be necessary for tamping, etc., during back filling work.

5) Filling-in shall be done in layers not exceeding 150 mm in thickness accompanied by adequate watering, ramming, etc., so as to get good compaction up to 300 mm above the top of the pipe. Above this level, useful excavated earth free from boulders shall be placed in layers of 150 mm, watered and compacted by tamping. Wherever pipe is laid in the storm water channel, total refilling shall be done with borrowed earth or as directed.

6) The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place.

7) Before and during the backfilling of the trench, precautions shall be taken against the floatation of the pipeline due to the entry of large quantities of water into the trench causing an uplift of the empty or the partly filled pipeline.

8) In case of sewers laid in storm water channels, after refilling is done, the bed of the channel to the extent trench width shall be made with cement concrete of grade M15 with a thickness of 150mm as per the site requirement and as directed.

9) Optimum Moisture Content (OMC) test to be carried at trench section and Maximum Dry Density (MDD) test for the refilled soil in trench to confirm the proper compaction up to 95% of maximum dry density.

## 1.27 Refilling the road surface

After the backfilling is completed, the contractor shall restore the surface of the trench over the pipe to that road surface existing prior to excavation, i.e., either bitumen or cement concrete as the case may be and verified from the adjacent surface. This will be paid as per the Bill of Quantities. The width for the payment of road cutting or restructuring will be only as per the direction of the Engineer. The work of restructuring of road surface either by bitumen or cement concrete shall be as described in chapter Road restoration.

## 1.28 Subsidence in filling

Should any subsidence take place in the filling at any place of work i.e. at manholes and over pipe trenches and road surface whatsoever during contract, the contractor shall make good the same at his own cost or the engineer may with or without notice to the contactor make good the same in

any way and with any material that he may think proper, and at the expense of the contractor. The engineer may also, if he anticipates the occurrence of any subsidence, take necessary action deemed fit in which case also the expenses therefore shall be charged to the contractor.

### 1.29 Disposal of excavated materials

Excavated materials shall be used for refilling etc. and surplus earth shall be disposed off to the outskirts of corporation safely with all leads and lift as directed by the engineer. In case of pipe laying work to be carried at the outer periphery of the lakes, the excess material shall be used for filling and embankment formation along the outer periphery of the lakes for laying of the sewer network

### 1.30 All works to be clear, clean and perfect

The Contractor, after completion of entire work and before seeking settlement of his final bill, shall prove at his expense that the entire line is clear, clean and perfect in the presence of the Engineer or his authorized subordinate. He should provide suitable instruments, appliances etc., and pass them through the pipes and shall show that water passes freely through the entire reach from higher end to lower end. Necessary precautions such as those indicated hereunder may be taken by the Contractor while checking the completed sewer line for its effective functioning, wherever required.

The manholes should be kept open, as required for one hour or as required, prior to the starting of checking operations and should be so kept open during the whole duration of checking operations. This is to be done for allowing the gases to escape, naturally. In order to prevent fire and explosions, .endangering the life, properties, sewers and other utility services due to presence of combustible gases, no lighted match sticks or other similar material should be thrown in the manhole. All necessary safety equipment’s, gadgets and sensors shall be used in the restricted working areas.

Meshes should be placed over the opened manholes to prevent pedestrians etc., from falling in. Likewise, caution boards printed in fluorescent letters such as "DANGER MANHOLE IS KEPT OPEN" etc., shall be provided.

### 1.31 Laying of sewer pipes along the water body

It is to be noted that sub-mains/trunk lines needs to be laid along the edge of tank/water bodies. If permitted, the edge of the tank shall be first filled with earth and later pipe laying work can be taken up and the excess soil shall be used for this purpose.

### 1.32 Measurement and payment

The payment of excavation shall be made on quantity basis as per the actual dimensions of the trench excavated limited to the width shown in the drawings or as directed.

**a) Trench excavation**

The length of the trench excavation shall be measured along the centre line of pipe at various depths stated in the Bill of Quantities, the total length being segregated into stretches according to the various depths of excavation contained in the Bill of Quantities to fall into the specified categories. Within each stretch the depth applicable shall be within the range specified in Bill of Quantities.

The depth of excavation shall be measured from the top of the trench at the centre before excavation upto the bottom of the bedding under the pipe. If no bedding is provided, the measurement shall be to the level of the bottom of the pipe line. The width of the trench shall be measured on the basis of vertical side walls and the specified widths. No additional payment shall be made for the widening at sockets, specials, hunching or surrounds beyond the dimensions specified.

**b) Structures**

Measurement for structure excavation shall be made as per the projection in plan of the outermost edges of the, structure as per the plan at the bottom.

**c) Rock excavation**

The depth of rock excavation measured for payment shall not exceed the corresponding depth in ordinary excavation or as directed by the Engineer.

In all above cases, no payment will be made for additional selected fill, lean concrete, bedding cradling or hunching concrete that may be specified or ordered by the Engineer as a consequence of excavating beyond the limits specified in the contract documents or ordered by the Engineer.

The contractor has to auction/dispose/use himself the excavated hard rock as per GOK guidelines and the revenue generated in this manner will be recovered in his payment at the prevailing rate of Royalty with applicable GST.

**d) Disposal of excavated material**

All the excavated material shall be carted away and the contractor shall be paid as per the Bill of Quantities and it includes loading, unloading, transporting with all lead and lift and as per Engineers directions.

## SECTION 2

## CONCRETE AND ALLIED WORKS

### 2.0 General

The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise shall conform to the applicable portions of this specification.

The Engineer shall have the right to inspect the source/s of material/s, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer's approval obtained, prior to starting of concrete work. However, this shall not relieve the contractor with any of his responsibilities and all the materials, which do not conform to the specifications, will be rejected. The detailed specifications are provided in Part 10-A, Standard Technical Specifications